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ABSTRACT

This document is a competency-based curriculum guide designed to promote articulation in electronics technology programs between and among secondary and postsecondary institutions in the Indian Hills Community College and Merged Area XV high schools in Iowa. The guide is organized in eight sections. The first six sections provide background information about the articulation project, the audiences served and competencies developed, testing procedures, and provisions for transfer of credits. Section VII, which makes up the greater part of the document, details the five competencies needed by entry-level electronics technicians and the enabling tasks needed to become proficient in the competencies. Each competency consists of three parts that, when used in combination, provide a detailed outline of major tasks that a student must accomplish to reach one or more previously stated student outcomes. The three parts are the task that the student must accomplish, the conditions under which the student must demonstrate the skills, and standards of acceptable performance. Multiple-choice tests and student competency records are included in each competency section. The final section of the guide lists job titles with relevant competencies. (KC)

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A COMPETENCY BASED ARTICULATED CURRICULUM FOR

ELECTRONICS TECHNOLOGY

A pilot project undertaken in cooperation with The Iowa State Department of Public Instruction

CE039899

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I. STATEMENT OF AUTHORSHIP

ELECTRONICS

The Director of this project is indebted to the following persons for their exemplary contributions to this publication. Compilation of this model reflects individual faculty preferences. Attempts to reproduce the effort with different faculty will likely produce variances in style.

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II. INTRODUCTION

INTRODUCTION

Indian Hills Community College, the twenty-six Local Education Agencies of Merged Area XV, Southern Prairie Area Education Agency XV (AEA), and the Iowa State Department of Public Instruction share a common commitment to offer current vocational opportunities to Iowans. This commitment has been demonstrated by undertaking a competency based Vocational Articulation project. In an effort to improve opportunities for students of secondary and post-secondary programs in Merged Area XV, those institutions mentioned above endeavored to create a solution to curricular problems such as redundancy, and gaps in subjects, occurring between secondary and post-secondary institutions. On October 21, 1981, an effort toward modifying existing curriculum was initiated by the Iowa Department of Public Instruction, Indian Hills Community College, Southern Prairie Area Education Agency XV, and all local Education Agencies in Merged Area XV. Persons instrumental in conceiving the project include: Jim Athen, Director of Career Education and Dr. Howard Hammond, Director of Teacher Certification, State Department of Public Instruction; Dr. John Van Ast, Associate Professor of Higher Education, Iowa State University; Ed Kuntz, Principal of Ottumwa High School; and Dr. Stephen M. Poort, Dean of Instruction, Indian Hills Community College.

III. ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

I am especially indebted to the members of the task force who provided sound counsel and strong support throughout the duration of this 24 month project. Task force members serving on behalf local secondary schools were: Dave Hotchkiss, Drafting (Ottumwa); Carol Gullion, Secretarial (Ottumwa); Ron Langgin, Electronics (Ottumwa); Keith Wells, Agriculture (Fairfield); Scott Moxom, Agriculture (Blakesburg); Harley Hecker, Welding (Ottumwa); and Carl Lawrence, Machine Shop (Ottumwa). Serving as task force members on behalf Indian Hills Community College were: Carl Moore, Drafting; Linda Poli and Connie Schmitz, Secretarial; Jerry Harshman, Electronics; Charles Rosenbalm and Dave McQuoid, Welding; and Everett Pilkington, Agriculture. Garland Ashbacher, Kirkwood Community College, served in support of the Agriculture model.

A special word of appreciation is due the following persons for their assistance in shaping the final form of this project. They are: Ed Kuntz, Principal and Ed Meyer, Vocational Director, Ottumwa High School; Don Smith, Consultant, State Department of Public Instruction; Ray Wingate, Educational Services Director, (AEA); Chuck Lawson, Vocational Director, Indian Hills; Bob Allison, Business Technologies Chairperson, Indian Hills; Dallas Dorsey, Trades and Industries Chairperson, Indian Hills; Betty Guest, Project Secretary; and Lew Debo and Shannon Vesely, Editors. Recognition should also be given to the selected private sector persons who helped on two occasions to reaffirm those competencies developed by task force members for each of the six vocational curriculum models.

It was our purpose to put forth a road map on the articulation process that could be emulated by interested educators elsewhere in Iowa. The effort described in this model is one of six end products of the total articulation process. Should the reader desire a copy of the final report he/she should contact Jim Athen, Director of Career Education, State Department of Public Instruction, Grimes State Office Building, Des Moines, Iowa 50319.

Stephen L. Poort, Ed.D
Project Director

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Project Coordinator

IV.

PROJECT POLICY STATEMENT

DEFINITION OF ARTICULATION

AUDIENCES SERVED

COMPETENCIES DEVELOPED

PROJECT POLICY STATEMENT

DEFINITION OF ARTICULATION

Articulation, as defined in this project, is the sequential development of occupational competencies in a non-repetitive fashion building from simple to more complex competencies.

This project provides an articulated system for coordinating the preparation of students to enter the world of work. It is intended to: (a) assure the quality of training at various levels; (b) eliminate repetition and learning gaps as students move from one level of mastery to the next; (c) provide uniform methods of measuring acquired skills of students in various competencies; (d) record those measurements for the benefit of students, prospective employers, and educators who would improve quality of curriculum; (e) encourage employers to match personnel qualifications to specific job requirements; and (f) enable beginning students to understand what they are expected to learn.

AUDIENCES SERVED

Project materials are designed for use by any or all of the following educationally-related groups: students, teachers, administrators, counselors, private sector representatives, and college registrars. Applications vary in accordance with user needs; however, specific suggestions on recommended usage can be found in the body of the final report.

COMPETENCIES DEVELOPED

Competencies have been developed for each of the six vocational programs and articulated from the secondary to the post-secondary level. A separate listing of those competencies can be found in the body of each of the models.

V. TESTING PROCEDURES

TESTING PROCEDURES

The following represents those testing procedures in place as of June 30, 1984.*

	Test on Secondary Level	Test on Post-Secondary Level	Competency Record Maintained
AGRICULTURAL OCCUPATIONS	X		X
BUSINESS OCCUPATIONS	OPTIONAL	X	X
DRAFTING		X	X
ELECTRONIC TECHNOLOGY		X	X
MACHINE TRADES		X	X
WELDING OCCUPATIONS		X	X

For answers to more specific questions regarding testing competency based articulated curriculum, participants are encouraged to contact any of the task force representatives identified on the authors' page of this model.

*Additional information such as individual course listings can be provided by contacting any of the authors of this curriculum model as well as the college registrar.

VI. TRANSFER OF CREDIT

TRANSFER OF ELECTRONICS CURRICULUM

EXAMPLE

SECONDARY

COMPETENCIES	CREDITS	CATALOG NO.	COURSE
1,2,3,4,5	1 credit (2-4 yrs)	#234	Electricity I
		235	Electronics II

POST-SECONDARY

1,2,3,& 5	4	EL071T	Basic Electricity I
4 & 5	2	EL010U	Electronic Devices

VII. COMPETENCIES

COMPETENCIES

Each competency consists of three parts that, when used in combination, provide a detailed outline of a major task that a student must accomplish to reach one or more previously-stated student outcomes. Competencies are described as follows:

a. Task - what the student must accomplish to demonstrate ability to perform the job outlined.

b. Conditions - A description of the circumstances under which the student demonstrates the skill. Usually included are:

   1. time allowance;
   2. tolerances allowed;
   3. references utilized;
   4. specific materials and tools needed;
   5. work location (if other than school site);
   6. and, other limitations unique to the task.

c. Standards of Acceptable Performance - Criteria described that constitute acceptable performance.

   These criteria must:

   1. be compatible with the task and condition;
   2. evaluate all components of the conditions;
   3. include the percentage of responses that must be correct if the competency is primarily cognitive;
   4. and, specify the standard of the criteria.

Competencies needed for initial employment are represented in this model. They are neither designated nor described by grade level. A student may complete all competencies available at a school subject to learning capability and time limitations. Competencies listed in this model do not attempt to represent all those taught at any participating secondary or post-secondary school.

COMPETENCY NO. 1

TASK:

TO DEMONSTRATE A WORKING KNOWLEDGE OF SOLDERING, SAFETY AND THE USE OF HAND TOOLS.

CONDITIONS AND LIMITATIONS:

The student will safely demonstrate his/her ability in soldering and the use of hand tools. Student performance will be evaluated upon criteria determined by the instructor, who may utilize oral or written testing procedures.

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Demonstrate proper attitude and safety techniques.
2. Solder and desolder electronic components.
3. Show use and care of soldering gun and pencil.
4. Make selection of solder.
5. Successfully construct an electronic project and demonstrate competence in the following:

   Tool use

   Chassis layout

   Soldering

   Assembly techniques

   Inspection and testing

ENABLING TASKS

COMPETENCY NO. 1 - TO DEMONSTRATE A WORKING KNOWLEDGE OF SOLDERING, SAFETY AND THE USE OF HAND TOOLS.

Solder and desolder components
- electronic components to printed circuit board

Use and care of desoldering and soldering aids

Use solder wick

Select correct solder

Visually inspect and repair circuit board

Solder connections
- grainy
- cracks
- oxidation
- opens
- bridges
- lifted foils
- pad holesfilled
- solder flow
- burns of discoloration
- broken wires
- cold solder joints
- breaks in foil
- feed through for solder starvation

Circuit board components
- cracks in board
- shorts and opens
- broken, charred, or damaged components
- frayed wires
- melted insulation

Live circuit inspections
- listen for "pops and sizzles"
- perform "sniff" test
- perform "touch" test
- look for smoke, melting insulation, and arcs

ENABLING TASKS
PAGE 2

Safe use and care of hand tools
- diagonal pliers
- long nose pliers
- wire stripper
- heat sink
- soldering gun
- soldering pencil
- IC insertion and extractor tool
- crimpers
- standard screw driver
- Phillips screw driver

Tinning
- wire
- soldering tip

Make chassis layout
- switch
- printed circuit board
- light emitting diode
- neon lamp
- transformer
- safety inspection

Assemble printed circuit board
- chassis
- safety

Classes of fire extinguishers
- "A"
- "B"
- "C"

Methods of fire extinguishers
- "A"
- "B"
- "C"

Identify ten safe laboratory conditions

Identify ten hazardous laboratory conditions

TEST

COMPETENCY NO. 1 - TO DEMONSTRATE A WORKING KNOWLEDGE OF SOLDERING, SAFETY AND USE OF HAND TOOLS.

Select the correct answer.

1. When using machines or hand tools:
   a. give the job all your attention
   b. stand up straight
   c. watch your classmates
   d. watch the clock

2. Report to the Supervisor
   a. damaged tools and equipment
   b. missing guards
   c. equipment not working properly
   d. all of the above are correct

3. Most tools are designed for a specific use or purpose. If they are used incorrectly, the result may be:
   a. damage to the student's project
   b. breakage of tools
   c. injury to the students
   d. damage to the bench tops

4. Caution others if you see a violation of shop:
   a. traffic rules
   b. good manners
   c. safety rules
   d. none of the above are correct

5. When handling electrical switches, plugs, or receptacles be sure your hands are dry because:
   a. a switch will not operate properly if your hands are wet
   b. a plug will easily slip from your fingers if your hands are wet
   c. if your hands are wet, you may receive a severe shock and serious burns
   d. none of the above are correct

6. If you notice any breakage or damage to tools, instruments, or machinery, you should:
   a. repair the damage yourself
   b. be careful when using such equipment
   c. say nothing because you might get the blame
   d. none of the above are correct

7. Eye protection is used to:
   a. improve your vision
   b. prevent eyestrain
   c. prevent flying particles or corrosive substances from entering your eyes
   d. none of the above are correct

8. Extension and power cords should always be checked and kept in good repair because:
   a. breaks and tears in the cord are unsightly
   b. breaks and tears in the cord can cause serious shocks or burns
   c. sparks may cause wood to burn
   d. a short may cause the machines to burn up

9. Carbon dioxide (CO^2) fire extinguishers may be used to put out what types of fires?
   a. electrical fires only
   b. wood fires only
   c. paper fires
   d. none of the above are correct

10. Water should never be used to put out what kind of fires?
   a. wood fires
   b. electrical fires and oil fires
   c. paper fires
   d. none of the above are correct

11. The proper procedure to fight a fire with a fire extinguisher is to:
   a. point the nozzle at the top of the flame
   b. point the nozzle at the middle of the flame
   c. cover the area around the fire and keep it from spreading
   d. point the nozzle at the source of the fire because that is where the fire is located

12. Check a soldering iron for heat with:
   a. your face
   b. your hand
   c. a piece of solder
   d. your feet

13. To remove excess soldering from a soldering iron tip:
   a. wipe with a cloth
   b. flip it off
   c. wash it off
   d. use cleaning fluid

14. When changing components in an electrical circuit:
   a. leave the plug in
   b. pull the plug out
   c. turn the circuit on its side
   d. turn off the power switch

Circle T or F.

T F 15. Wire strippers are used to remove the insulation from wires.

T F 16. A stranded wire is less flexible than a solid wire of the gauge.

T F 17. Soldering irons are available in many shapes, sizes, and wattage ratings. For general project work, a 25-35 watt iron is appropriate.

T F 18. A 24-gauge wire has a larger diameter than a No. 12 American Wire Gauge wire.

T F 19. When fastening a wire to a screw terminal, the wire should be wound around the screw in a clockwise direction.

T F 20. Diagonal-cutting pliers are designed for stripping wires.

T F 21. Long-nose pliers are designed primarily for holding and bending small-gauge wires.

T F 22. A Phillips head screw can be driven by either a standard blade screwdriver or a Phillips screwdriver.

T F 23. The best conductor for most electrical work is copper.

T F 24. The type of solder used in electronic project construction is called 60/40 rosin core solder.

T F 25. A dull-colored, rough solder joint is acceptable as long as enough solder is used.

T F 26. A wire being soldered to a lug is usually first loosely fastened to the lug to hold it in place.

T F 27. Do not move or handle a newly soldered wire until the solder has completely hardened.

T F 28. The job of removing solder from a connection is done with a desoldering tool.

T F 29. Solder is a mixture of tin and flux.

T F 30. The process of coating a wire, terminal, or soldering iron tip with a layer of solder is called tinning.

T F 31. When soldering parts which are easily damaged by heat, a tool called a heat sink should be used.

STUDENT LABORATORY COMPETENCY RECORD

COMPETENCY NO. 1 - TO DEMONSTRATE A WORKING KNOWLEDGE OF SOLDERING, SAFETY AND USE OF HAND TOOLS.

Student's Name _____

Social Security No. _____

_____ _____ _____

Verification Signature (Instructor) Date School

		Satis-factory	Unsatis-factory
TASK: I	Demonstrate proper attitude and safety techniques.		
A.	Demonstrate common safe laboratory practices.		
B.	Show hazardous conditions in laboratory.		
C.	Demonstrate proficiency in the proper safety and first aid procedures when dealing with an electrical hazard of a serious shock.		
D.	Show proficiency in identifying the three classes or categories of fires, and indicate the proper method of extinguishing each.		
TASK: II	Demonstrate a fundamental knowledge of solder, soldering and desoldering of electronic components.		
A.	Demonstrate proper soldering techniques.		
B.	Show proficiency in preparing wires for soldering.		
C.	Demonstrate proper desoldering techniques.		
D.	Show proficiency in the proper selection of solder.		
TASK: III	Demonstrate proficiency in constructing an electronic project.		
A.	Demonstrate the correct use of electronic tools.		
B.	Show proficiency in identifying electronic tools.		
C.	Show proficiency in chassis layout.		
D.	Show proficiency in soldering.		
E.	Show proficiency in electronic project assembly techniques.		
F.	Show proficiency in inspection and testing of electronic project.		
G.	Demonstrate proper use and care of soldering gun and pencil.		

COMPETENCY NO. 2

TASK:

TO DEMONSTRATE A WORKING KNOWLEDGE OF DIRECT CURRENT CIRCUITS.

CONDITIONS AND LIMITATIONS:

The student will demonstrate his/her competency of direct current circuits. Student performance will be evaluated upon criteria determined by the instructor, who may utilize oral or written testing procedures.

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Connect batteries for various voltages.
2. Design and construct voltage dividers.
3. Use direct current power supplies.
4. Determine current, voltage and power in DC circuits:

   Series

   Parallel

   Series-parallel

5. Connect resistors, pilot lamps and switches as indicated in schematic drawing.
6. Read resistor color code and check resistance with ohmmeter.
7. Identify sources and methods of producing electricity.
8. Demonstrate through problem solving the proper procedures to follow when completing an addition, subtraction, multiplication and/or division problem.

ENABLING TASKS

COMPETENCY NO. 2 - TO DEMONSTRATE A WORKING KNOWLEDGE OF DIRECT CURRENT CIRCUITS.

Use of VOM and DVM
- resistance
- DC voltage
- continuity checks
- current

Regulated DC power supply
- voltage settings
- current limit
- polarity identification

Circuit construction
- series
- parallel
- series parallel

Component identification and applications
- potentiometer
- reostates
- fuses
- pilot lamps
- thermistors
- resistors
- heating elements
- batteries
- switches

Circuit applications
- current limiting
- voltage dividers
- balanced bridge
- dc relay
- temperature sensing
- switching

TEST

COMPETENCY NO. 2 - TO DEMONSTRATE A WORKING KNOWLEDGE OF DIRECT CURRENT CIRCUITS

Select the correct answer.

1. A 1k ohm resistor would be the same as a:
   a. 100 ohm resistor
   b. 1000 ohm resistor
   c. .1 ohm resistor
   d. 10 ohm resistor

2. Two 1.5V batteries are connected in series. The total voltage of the source is:
   a. 1.5V
   b. 3.0V
   c. 0.75V
   d. 1.0V

3. A current measurement of 0.01A would be the same as:
   a. 1A
   b. 1mA
   c. 10mA
   d. 100mA

4. Which formula is <u>not</u> correct?
   a. I = E/R
   b. R = E/I
   c. E = IR
   d. R = I/E

5. Two 100 ohm resistors connected in series would have a total resistance of:
   a. 50 ohms
   b. 100 ohms
   c. 200 ohms
   d. none of the above are correct

6. The voltage applied to the circuit shown in figure 1 is:
   a. 10V
   b. 50V
   c. 0.5V
   d. 5V

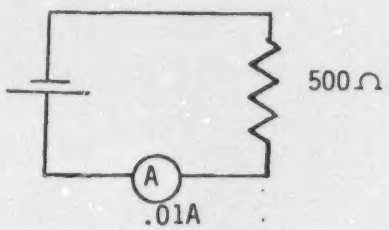


Figure 1

7. If the applied voltage to the circuit shown in figure 1 is doubled, the current would:
   a. half
   b. double
   c. remain the same
   d. decrease to zero

8. The ammeter shown in figure 2 would indicate:
   a. 5mA
   b. 10mA
   c. .05mA
   d. 5A

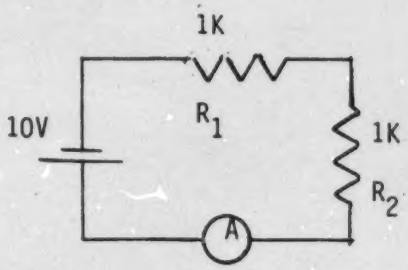


Figure 2

9. The power dissipated by the circuit shown in figure 2 is:
   a. 50mW
   b. 5mW
   c. 5W
   d. none of the above are correct

10. The voltage across resistor R1 in figure 2 is:
    a. 10V
    b. 5V
    c. 20V
    d. 1V

11. Two 1W resistors connected in parallel can safely dissipate:
    a. 1W
    b. 2W
    c. ½W
    d. none of the above are correct

12. A 1K ohm resistor and a 2K ohm resistor are connected in parallel. The total resistance is:
    a. 3K ohms
    b. 1.5K ohms
    c. 666 ohms
    d. 6.66K ohms

13. The total resistance for the circuit shown in figure 3 would be:
    a. 5K ohms
    b. 2K ohms
    c. 0.5K ohms
    d. none of the above are correct

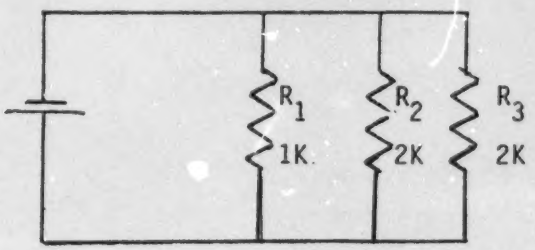


Figure 3

14. If a 100V source is connected across the circuit shown in figure 3, the power dissipated by R2 would be:
    a. 10W
    b. 5W
    c. 20W
    d. none of the above are correct

15. Which formula is <u>not</u> correct?
    a. $I = \sqrt{P/R}$
    b. $E = \sqrt{PR}$
    c. $P = E/I$
    d. $P^2 = I^2E^2$

16. If two ammeters are connected in series, the total current through the two meters is:
    a. the reading of one of the meters
    b. one-half the reading on one meter
    c. the sum of both readings
    d. the reading of one meter minus the reading of the other

17. A resistor rated at 20 watts, 8000 ohms has 300 volts dropped across it:
    a. its rating has been exceeded
    b. the current is 0.05 amp
    c. the circuit current squared is 1/400 A
    d. none of the above are correct

18. Two resistors are connected in series across a 75 volt source. One dissipates 25 watts, the other 30 watts.
    a. the voltage across one is 10 volts
    b. the total power is 75 watts
    c. the current is 734 milliamperes
    d. the resistance of one resistor is 17 ohms

19. Two #47 pilot lamps (6V @ 0.15A) are connected in parallel. Calculate the series dropping resistor required if the source is 10 volts.
    a. 26.6 OHMs
    b. 40 OHMs
    c. 13.3 OHMs
    d. 33.3 OHMs

20. Three resistors R_1, $R_2 = 2R_1$, $R_3 = 3R_1$ are connected in series across a source of 90 volts.
    a. the voltage across R_2 is 30 volts
    b. the voltage across R_2 is 40 volts
    c. the voltage across R_1 is 60 volts
    d. none of the above are correct

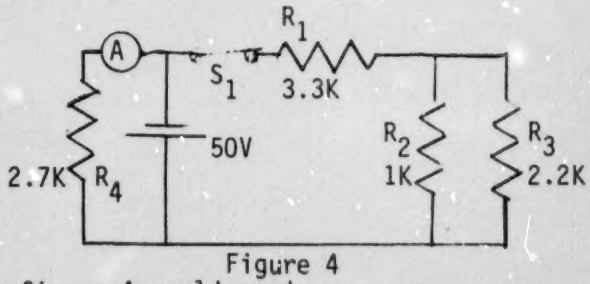


Figure 4

21. The ammeter shown in figure 4 would read:
    a. 0.25 A
    b. 0.025 A
    c. 1.85mA
    d. none of the above are correct

22. A voltmeter connected across switch S1 in figure 4 would read:
    a. 0V
    b. 50V
    c. 5V
    d. none of the above are correct

23. Resistor R3 in figure 4 opens, the ammeter reading would:
    a. increase
    b. decrease
    c. remain the same
    d. drop to zero

24. If switch S1 in figure 4 is in the <u>open</u> position, a voltmeter placed across the switch would read:
    a. 10V
    b. 0V
    c. 50V
    d. none of the above are correct

25. The power dissipated by resistor R3 in figure 5 would be:
    a. 6.39W
    b. 0.639W
    c. 0.0639W
    d. none of the above are correct

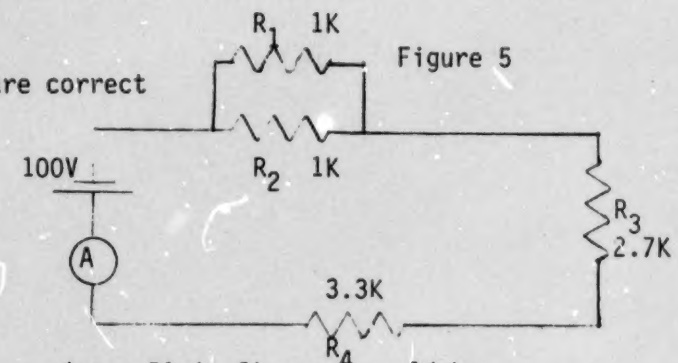


Figure 5

26. The voltage drop across resistor R1 in figure 5 would be:
    a. 7.69V
    b. 15.38V
    c. 6.69V
    d. none of the above are correct

27. The total power dissipated by the circuit shown in figure 5 would be:
    a. 1.75W
    b. 1.25W
    c. 1.54W
    d. none of the above are correct

28. A voltmeter connected across resistor R3 in figure 6 would read:
    a. 0V
    b. 10V
    c. 1V
    d. 20V

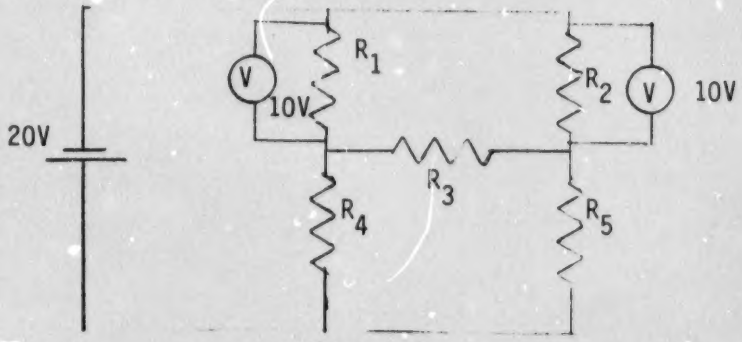


Figure 6

29. A voltmeter connected across resistor R4 in figure 6 would read:
    a. 5V
    b. 1V
    c. 20V
    d. none of the above are correct

30. A resistance value of 700 ohms is required. If a 1K ohm resistor is available, the resistance value required in parallel would be:
    a. 2.33K ohm
    b. 1.33K ohm
    c. 2.66K ohm
    d. none of the above are correct

31. The ammeter shown in figure 7 would read:
    a. 1A
    b. 1.5A
    c. 2.5A
    d. 0.0A

32. If lamp L3 in figure 7 opens (burns out), the intensity of L1 would:
    a. increase
    b. decrease
    c. remain the same
    d. burn out

33. The voltmeter in figure 8 would read:
    a. 12.5V
    b. 50V
    c. 25V
    d. 0V

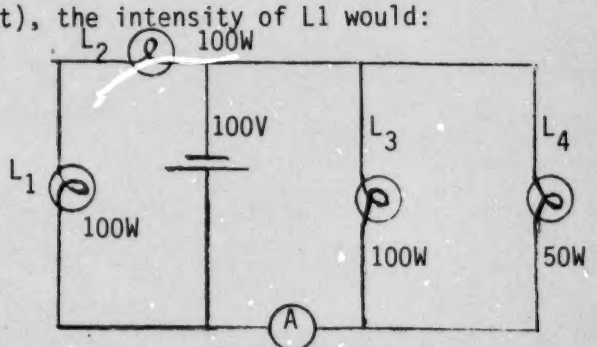


Figure 7

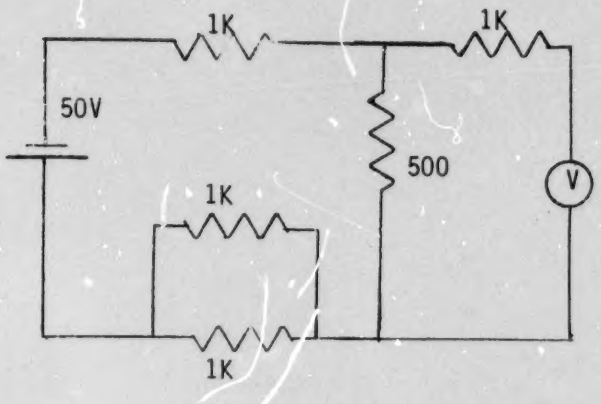


Figure 8

STUDENT LABORATORY COMPETENCY RECORD

COMPETENCY NO. 2 - TO DEMONSTRATE A WORKING KNOWLEDGE OF DIRECT CURRENT CIRCUITS.

Student's Name _____

Social Security No. _____

_____ _____ _____

Verification Signature (Instructor) Date School

		Satis-factory	Unsatis-factory
TASK: I	Demonstrate proficiency in direct current series circuit.		
	A. Show the correct technique for measuring current and voltage in a series circuit using a volt-ohm-milliammeter.		
	B. Prove Kirchhoff's law for voltage in a series circuit.		
	C. Demonstrate proficiency in following schematic diagrams when constructing a series circuit.		
	D. Demonstrate proper safety techniques.		
TASK: II	Demonstrate proficiency in direct current parallel circuits.		
	A. Demonstrate the correct use of a volt-ohm-milliammeter in measuring current and voltage in a parallel circuit.		
	B. Prove Kirchhoff's law for current in a parallel circuit.		
	C. Demonstrate proper laboratory techniques when constructing parallel circuits.		
	D. Demonstrate proper safety techniques.		
TASK: III	Demonstrate a fundamental knowledge of connecting and adjusting direct current power sources.		
	A. Show proficiency when working with batteries in both series and parallel configurations.		
	B. Demonstrate correct procedure to set a regulated power supply.		
	C. Construct a circuit using batteries to provide a negative and positive voltage in respect to ground.		
	D. Demonstrate proper safety techniques.		

COMPETENCY NO. 3

TASK:

TO DEMONSTRATE KNOWLEDGE OF FUNDAMENTALS OF ALTERNATING CURRENT AND MAGNETISM.

CONDITIONS AND LIMITATIONS:

The student will demonstrate his/her competency of alternating current and magnetism. Student performance will be evaluated upon criteria determined by the instructor, who may utilize oral or written testing procedures.

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Demonstrate an understanding of magnetic terminology and principles.
2. Explain the difference between AC and DC.
3. Convert periodic measurements to frequency.
4. Show AC applications in the audio spectrum.
5. State the purpose and fundamental principles of operation for motors and generators.
6. Identify need for conservation in the use of consumption of electrical energy.

ENABLING TASKS

COMPETENCY NO. 3 - TO DEMONSTRATE KNOWLEDGE OF FUNDAMENTALS OF ALTERNATING CURRENT AND MAGNETISM.

Use of test equipment

Oscilloscope to measure
- AC volts peak-to-peak
- DC volts
- frequency on linear timebase
- signal voltages
- RF generator
- AF generator

FET, VOM, and DVM
- AC voltage
- DC voltage

Construct soleniod

Construct electromagnet

Construct AC-DC motor

Component identification and application
- transformer
- inductor
- relay
- DC motor
- magnetic wire

Construct wind generator

Construct photoelectric cell

TEST

COMPETENCY NO. 3 - TO DEMONSTRATE KNOWLEDGE OF FUNDAMENTALS OF ALTERNATING CURRENT AND MAGNETISM.

Select the correct answer.

1. The small blocks of carbon which contact either the commutator or slip rings of a generator are called:
   a. brooms
   b. wipers
   c. rotors
   d. brushes

2. The frequency of the AC power generated in most parts of the United States is:
   a. 50 hertz
   b. 55 hertz
   c. 60 hertz
   d. 120 hertz

3. The rotor of an AC generator has a similiar function to the _____ of a DC generator:
   a. field magnet
   b. armature
   c. commutator
   d. brushes

4. If the ends of an armature coil are connected to a set of slip rings, and the armature is rotated within a magnetic field:
   a. alternating current will be generated
   b. the voltage produced will change in both value and direction
   c. direct current will be generated
   d. both a and b

5. Large AC generators, such as those used in power plants, can be turned by:
   a. steam turbines
   b. diesel engines
   c. hydro turbines
   d. all of the above are correct

6. During one cycle, the peak voltage occurs:
   a. five times
   b. twice
   c. once
   d. four times

7. A cycle is made up of two parts called
   a. peak voltages
   b. loops
   c. frequencies
   d. alternations

8. The number of cycles generated in a second is called:
   a. an alternation
   b. the sine curve
   c. the frequency
   d. an alternating current

9. Unless otherwise stated, AC meters read the:
   a. effective (RMS) values
   b. average values
   c. peak values
   d. .1416 x peak values

10. When a graph is drawn of an AC voltage the shape of the resulting curve is called the:
    a. phase
    b. waveform
    c. frequency
    d. none of the above are correct

11. A quarter cycle of an AC wave is the equivalent of:
    a. 45°
    b. 90°
    c. 180°
    d. 360°

12. Two AC voltages that are always "in phase" must have the same:
    a. current value
    b. voltage value
    c. frequency
    d. none of the above are correct

13. The average value of an AC sine wave voltage is solved by using the formula:
    a. .707 x peak
    b. .637 peak
    c. 1.414 x peak
    d. none of the above are correct

14. Alternating current is used as:
    a. a source of electrical power and as a means of carrying information or intelligence
    b. a source of power only
    c. a means of carrying information only
    d. an AC signal only

15. A device which utilizes electromagnetic induction as a means of producing an AC voltage is called:
    a. an oscillator
    b. an induction motor
    c. a battery
    d. an AC generator

16. The essential elements which are needed to form a basic AC generator are:
    a. slip-rings, brushes, and a magnetic field
    b. an armature, slip rings, and brushes
    c. slip-rings and brushes
    d. an armature, slip-rings, brushes, and a magnetic field

17. One cycle of an AC sine wave contains:
    a. two positive alternations and one negative alternation
    b. two negative alternations
    c. only one alternation
    d. one positive alternation and one negative alternation

18. The maximum value which occurs during an alternation of a sine wave is called the:
    a. peak point
    b. peak value
    c. peak-to peak value
    d. positive peak-to-peak value

19. Identify the square wave in the drawings below:
    a.
    b.
    c.
    d.

20. An AC voltage has a peak value of 10 volts, hence its peak-to-peak value is:
    a. 10 volts p-p
    b. 7.07 volts p-p
    c. 6.37 volts p-p
    d. 20 volts p-p

21. Given a value of $40V_{RMS}$, what is the effective AC value?
    a. $20V_{EFF}$
    b. $80V_{EFF}$
    c. $28.28V_{EFF}$
    d. $40V_{EFF}$

22. Around each magnet is:
    a. negative charge
    b. current
    c. a voltage
    d. a magnetic field

23. A magnet which keeps its magnetism for only a short time is:
    a. a permanent magnet
    b. made of soft iron
    c. a temporary magnet
    d. both b and c

24. The basic law of magnetism says
    a. unlike poles repel
    b. likes poles repel
    c. two south poles attract
    d. like poles attract

25. Which of the following operates by magnetism or magnetic force?
    a. electric motor
    b. electric buzzer
    c. electric bell
    d. all of the above are correct

26. Which pole of a magnet has the most magnetic strength?
    a. N-pole
    b. S-pole
    c. both poles have equal strength
    d. will vary from one magnet to the next

Circle T or F.

T F 27. A generator is used to convert electrical energy into mechanical or rotational energy.

T F 28. DC motors and DC generators are very similar in construction.

T F 29. All electric motors operate by the principle of magnetic or electromagnetic attraction and repulsion.

T F 30. Electric generators operate by the principle of electromagnetic induction.

T F 31. A generator will produce electricity using either a stationary magnetic field and revolving coil, or by using a rotating magnetic field and a stationary coil.

T F 32. DC generators produce an electric current which flows first in one direction, stops and then flows in the opposite direction.

T F 33. Friction and dirt are a major cause of motor failure and overheating.

T F 34. Power plants are commonly operated using either fossil fuels or hydropower.

T F 35. The "size" of an electric motor is given in terms of watts or horsepower.

T F 36. Moving a piece of wire through a magnetic field will induce a voltage between the ends of the wire.

T F 37. If the speed at which a wire cuts the magnetic field is increased, the voltage generated will also be increased.

T F 38. The type of electricity supplied to our homes is DC.

T F 39. Radio signals are considered AC type electricity.

T F 40. DC generators and AC generators work by the same electrical principle electromagnetic induction.

T F 41. 90 degrees and 270 degrees are the only maximum points on the AC wave.

T F 42. The higher the frequency, the closer together the sine waves will appear on the screen of an oscilloscope.

T F 43. The period of a DC wave is measured in seconds.

T F 44. If two AC waves start and end at the same place on an oscilliscope screen, they are out of phase.

T F 45. A permanent magnet cannot be destroyed or weakened.

T F 46. As two magnets are moved apart, their force of attraction increases.

T F 47. An electromagnet must have electricity flowing through it to produce a strong magnetic field.

T F 48. The frequency of the AC power supplied to our homes is 117V.

T F 49. A transformer has the ability to either step-up or step-down an AC voltage.

T F 50. High frequency AC signals, called radio waves, can travel through the air over long distances.

T F 51. Of the many sources of energy available, fossil fuel is the most widely used.

T F 52. Fortunately, the earth has a large supply of usable energy so we need not conserve.

T F 53. Most power plants use steam from heated water to turn a turbine generator.

T F 54. Solar energy supplies both heat and light which can be put to work making electricity or heating liquids.

MATCHING

Record the letter of the answer which best matches the numbered terms.

_____ 55.	fossil fuel	a. coal, petroleum, natural gas
_____ 56.	hydro power	b. heat and light provided by the sun
_____ 57.	solar power	c. saving or limiting the use of a resource
_____ 58.	conservation	d. the heat produced by atomic fission
_____ 59.	nuclear power	e. energy provided by running or falling water

STUDENT LABORATORY COMPETENCY RECORD

COMPETENCY NO. 3 - TO DEMONSTRATE KNOWLEDGE OF FUNDAMENTALS OF ALTERNATING CURRENT AND MAGNETISM.

Student's Name _____

Social Security No. _____

Verfication Signature (Instructor) _____ Date _____ School _____

		Satis-factory	Unsatis-factory
TASK: I	Demonstrate proficiency with magnetic terminology and principles.		
	A. Show proficiency in explaining the laws of magnetism related to poles of a magnet.		
	B. Show proficiency in describing the three fundamentals categories for classifying magnets.		
TASK: II	Demonstrate proficiency in explaining the difference between AC and DC.		
	A. Show proficiency in explaining an AC waveform.		
	B. Show proficiency in explaining a DC waveform.		
	C. Demonstrate proficiency in explaining the major reasons why AC is utilized as our primary source of power in the home.		
TASK: III	Demonstrate proficiency in converting periodic measurement to frequency.		
	A. Show proficiency in converting periodic measurement to frequency.		
TASK: IV	Demonstrate proficiency with AC applications in the audio spectrum.		
	A. Show proficiency in identifying the audio ranges of frequency within the frequency spectrum.		
	B. Show proficiency in identifying the radio ranges of frequency within the frequency spectrum.		

		Satis-factory	Unsatis-factory
TASK: V	Demonstrate proficiency in stating the purpose and fundamental principles of operation for motors and generators.		
	A. Show proficiency in explaining the purpose of an electrical motor.		
	B. Show proficiency in explaining the purpose of a generator.		
	C. Show proficiency in explaining causes of motor failure.		
TASK: VI	Demonstrate proficiency to identify need for conservation in the use or consumption of electrical energy.		
	A. Identify the major sources of the earth's energy and describe each.		
	B. Identify alternative methods for the generation of electricity.		
	C. Show proficiency in discussing the need for conservation of electrical energy.		

COMPETENCY NO. 4

TASK:

TO DEMONSTRATE A BASIC KNOWLEDGE IN THE TESTING AND APPLICATION OF ELECTRONIC DEVICES.

CONDITIONS AND LIMITATIONS:

The student will demonstrate his/her competency in the use of various electronic devices. Student performance will be evaluated upon criteria determined by the instructor, who may utilize oral or written testing procedures.

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Identify and apply electronic devices:

resistors	diodes
transformers and chokes	switching devices
transistors	xenon flashtubes
inductors	neon lamps
capacitors	batteries
speakers	switches

2. Read resistor color code and check the resistance with ohmmeter.
3. Construct and measure DC voltages in transistor circuit.
4. Contruct and evaluate simple series diode circuit.

ENABLING TASKS

COMPETENCY NO. 4 - TO DEMONSTRATE A BASIC KNOWLEDGE IN THE TESTING AND APPLICATION OF ELECTRONIC DEVICES.

Use of VOM or DVM
- voltage
- current
- resistance

Use of DC power supply
- voltage settings
- current limit
- polarity identification

Circuit construction
- transistor circuits
- diode circuits
- relay circuits
- switching circuits

Component identfication and applications
- resistors
- transformers
- inductors
- capacitors
- transistors
- diodes
- silicon controlled rectifiers
- relays
- batteries
- neon lamps
- xenon flashtubes

Circuit applications
- temperature control
- amplifiers
- solid state switching
- relays switching
- oscillators
- variable lighting
- power supplies

TEST

COMPETENCY NO. 4 - TO DEMONSTRATE A BASIC KNOWLEDGE IN THE TESTING AND APPLICATION OF ELECTRONICS DEVICES.

1. Match the schematic symbols on the right with the circuit elements they identify.

_____a. Resistor

_____b. Conductors not connected

_____c. Lamp

_____d. Generator

_____e. Transformer

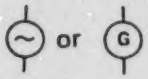
_____f. Relay open

_____g. Relay closed

_____h. Loudspeaker

_____i. Switch open

_____j. Battery

1.
2. 

3.
4.
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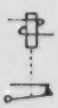
10. 
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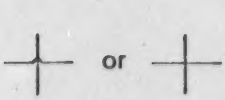
13. 

2. Match the schematic symbol on the right with the circuit elements they identify.

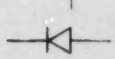
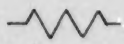
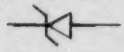
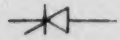
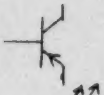
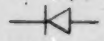
_____ a. diode

_____ b. NPN transistor

_____ c. SCR

_____ d. zener diode

_____ e. PNP transistor

1.
2. 
3. 
4. 
5. 
6. 
7. 

3. Match the resistance value on the right with the color value.

_____ a. red, violet, red

_____ b. green, blue, green

_____ c. yellow, violet, orange

_____ d. brown, black, black

_____ e. yellow, violet, red

1. 10 ohm
2. 2.7K ohm
3. 4.7K ohm
4. 5.6M ohm
5. 47K ohm
6. 100 ohm
7. 27K ohm
8. 470 ohm
9. 9.56M ohm
10. .47K ohm

Circle T or F

T F 4. The process of adding impurities to the semiconductor material is called doping.

T F 5. The potential barrier of a germanium P-N junction is about .7 volts.

T F 6. A P-N junction used as a capacitor is known as a zener diode.

T F 7. The letter symbol for a photoresistive cell would probably be L E D.

T F 8. Excessive reverse voltage applied to a diode will cause breakdown.

T F 9. A diode may be compared to a valve which opens only when its anode is positive with resepct to its cathode.

T F 10. In N-type material, electrons are the majority "current" carriers.

T F 11. Zener diodes are designed to operate in a state of high conduction with reverse bias.

T F 12. A triac will allow current flow in both directions.

T F 13. The unit of measurement for a capacitor is the farad.

T F 14. The unit of measurement of an inductor is the ohm.

T F 15. An ohmmeter connected across a capacitor would read approximately 10K ohms.

16. The voltmeter in figure 1 would read:
    a. 10V
    b. 0V
    c. 5V
    d. none of the above are correct

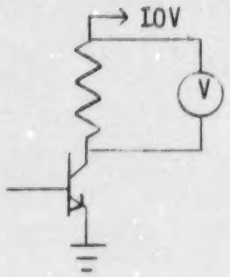


Figure 1

17. The voltmeter in figure 2 would read:
    a. .7V
    b. 10V
    c. 0V
    d. 1V

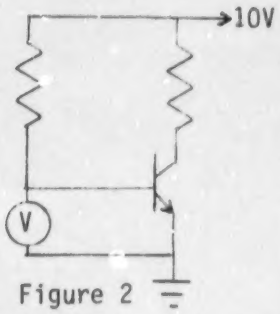


Figure 2

18. The correct formula for beta of a transistor is:
    a. B = IC/IE
    b. B = IB/IE
    c. B = IE/IC
    d. none of the above are correct

19. Electron flow in a diode is:
    a. against the arrow
    b. with the arrow
    c. in either direction
    d. zero

20. The ammeter in figure 3 would read approximately:
    a. 10mA
    b. 1mA
    c. 0.0A
    d. none of the above are correct

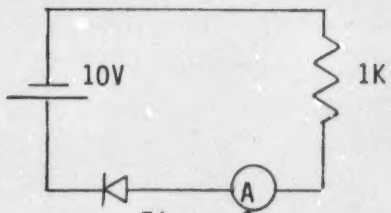


Figure 3

21. A voltmeter placed across the diode in figure 3 would read:
    a. .7V
    b. 10V
    c. 0V
    d. none of the above are correct

22. A voltmeter placed across the resistor in figure 4 would read:
    a. 10V
    b. 4V
    c. 5V
    d. 15V

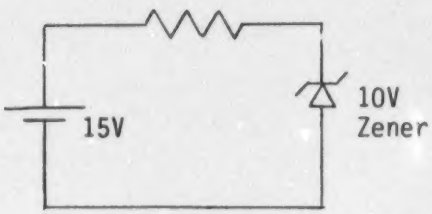


Figure 4

23. A transformer can:
    a. step up voltage
    b. step down currect
    c. provide isolation
    d. all of the above

24. The physical size of a resistor denotes its:
    a. ohmmic value
    b. wattage rating
    c. ability to create magnetic lines of flux
    d. none of the above are correct

25. A transistor may be used:
    a. to amplify
    b. as a switch
    c. both a and b
    d. none of the above are correct

STUDENT LABORATORY COMPETENCY RECORD

COMPETENCY NO. 4 - TO DEMONSTRATE A BASIC KNOWLEDGE IN THE TESTING AND APPLICATION OF ELECTRONIC DEVICES.

Student's Name _____

Social Security No. _____

_____ _____ _____

Verification Signature (Instructor) Date School

		Satis-factory	Unsatis-factory
TASK: I	Demonstrate the correct procedure for checking electronic devices with an ohmmeter.		
	A. Check forward and reverse resistance of a diode.		
	B. Check forward and reverse resistance of transistor junctions.		
	C. Determine the base lead of a transistor with an ohmmeter.		
	D. Check transformers and chokes for continuity and shorts.		
	E. Check capacitor for proper charging characteristics and shorts.		
	F. Determine if resistors are within tolerance.		
	G. Check relay coil and contacts.		
	H. Demonstrate proper safety techniques.		
TASK: II	Demonstrate the correct laboratory procedures when constructing circuits employing electronic devices.		
	A. Construct a series circuit using a diode and resistor.		
	B. Construct a series circuit using a relay and switch.		
	C. Construct a circuit using a transistor to energize a relay.		
	D. Correctly use a capacitor in a series circuit.		
	E. Construct a transistor circuit utilizing base bias and voltage divider bias.		
TASK: III	Demonstrate the correct measurement techniques using a volt-ohm-milliammeter.		
	A. Correctly measures collector and base voltage in a transistor circuit.		
	B. Correctly measures collector and base current in a transistor circuit.		
	C. Determine the state of a diode with a voltage measurement.		
	D. Determine the state of a switch with a voltage measurment.		

		Satis-factory	Unsatis-factory
TASK: IV	Demonstrate a proficiency in series-parallel and voltage dividers circuits.		
	A. Correct use of volt-ohm-milliammeter in series-parallel circuits.		
	B. Demonstrate proper laboratory techniques when constructing series-parallel circuits.		
	C. Select correct resistor values for current limiting and voltage divider applications.		
	D. Demonstrate proper safety techniques.		
TASK: V	Demonstrate correct procedures for determining the ohmmic value of resistive components.		
	A. Use color code to determine resistor value and tolerance.		
	B. Show correct procedures in checking resistive components with an ohmmeter.		
	C. Demonstrate proper safety techniques.		

COMPETENCY NO. 5

TASK:

TO DEMONSTRATE A WORKING KNOWLEDGE OF TEST EQUIPMENT.

CONDITIONS AND LIMITATIONS:

The student will demonstrate his/her competency of various types of test equipment. Student performance will be evaluated upon criteria determined by the instructor, who may utilize oral or written procedures.

CRITERIA OF ACCEPTABLE PERFORMANCE:

1. Use of multimeter to measure
   - voltage
   - current
   - resistance
2. Use of multimeter to check
   - resistors - potentiometers
   - capacitors
   - diodes - identify cathode lead
   - transformer resistance
   - transistors - determine PNP or NPN
   - continuity check
3. Use of oscilloscope to measure
   - peak-to-peak voltage
   - DC voltage
   - period of sine wave

ENABLING TASKS

COMPETENCY NO. 5 - TO DEMONSTRATE A WORKING KNOWLEDGE OF TEST EQUIPMENT.

Use of test equipment

FETVOM, VOM and DVM to measure
- continuity checks
- AC voltage
- DC voltage
- resistance
- AC current
- DC currrent

Oscilloscope to measure
- AC voltage
- DC voltage
- frequency on linear timebase

Circuit construction
- series
- parallel
- series parallel

Component testing and application
- potentiometer
- resistor
- diode
- transformer
- transistor (PNP and NPN)
- capacitor

TEST

COMPETENCY NO. 5 - TO DEMONSTRATE A WORKING KNOWLEDGE OF TEST EQUIPMENT.

Select the correct answer.

1. Which of the following controls may cause damage to the screen on the scope if it is incorrectly adjusted?
   a. intensity
   b. focus
   c. vertical position
   d. power switch

2. The amount of vertical deflection on a scope indicates the:
   a. peak value of voltage applied
   b. peak-to-peak value of voltage applied
   c. RMS value of voltage applied
   d. none of the above are correct

3. To convert an RMS AC sine wave voltage to its peak-to-peak equivalent, we multiply it by:
   a. 1.415
   b. 2.83
   c. .707
   d. .636

4. The part of a Cathode-Ray Tube which produces the electron beam is the:
   a. vertical deflection plates
   b. horizontal deflection plates
   c. electron gun
   d. none of the above are correct

5. Which of the following controls is used to adjust the clarity of the wave on an oscilloscope?
   a. intensity
   b. focus
   c. vertical gain
   d. horizontal position

6. The oscillopscope is able to measure which of the following electrical characteristics?
   a. AC voltage
   b. frequency
   c. phase relation
   d. all of the above are correct

7. Which of the following scope controls contributes to the stabilization of the displayed wave?
   a. brightness
   b. fine frequency adjustment
   c. horizontal positioning
   d. vertical gain

8. Of the instruments listed below, which has the ability to directly measure DC current?
   a. VTVM
   b. frequency counter
   c. DMM
   d. oscilloscope

9. The basic unit of measurement for voltage is the:
   a. watt
   b. ohm
   c. ampere
   d. volt

10. The letter symbol for current is:
   a. C
   b. I
   c. A
   d. E

11. is the electrical symbol for the:
   a. volt
   b. ampere
   c. resistor
   d. ohm

12. The orderly flow of electrons through a circuit is known as:
   a. current
   b. electromotive force
   c. resistance
   d. power

13. The electrical quantity which opposes the flow of electrons through circuit is called:
   a. voltage
   b. resistance
   c. ohm
   d. current

14. A multimeter is generally able to measure:
   a. voltage
   b. current
   c. resitance
   d. all of the above are correct

Circle T or F.

T F 15. A multimeter is a test instrument used to measure AC/DC volts and DC current only.

T F 16. A VOM contains an ohmmeter scale which is nonlinear and the scale generally reads from zero to infinity.

T F 17. A DMM is a test instrument which displays its measurement with a pointer deflecting on a continuous scale.

T F 18. The beam of electrons within a Cathode-Ray Tube is often called a cathode stream.

T F 19. There is a built-in signal in most scopes which is used to calibrate the instrument.

T F 20. The primary purpose of an oscilloscope is to show a picture or waveform on a screen in order that it may be measured or observed.

T F 21. When the electron beam within a Cathode-Ray Tube strikes the phosphor coating on the screen of the tube it causes the phosphor to glow.

T F 22. That circuit of an oscilloscope which causes the electron beam to move across the screen in a horizontal direction is called the horizontal sweep circuit.

T F 23. The signal to be observed by means of an oscilloscope is usually applied to the instrument at the vert. input jacks and terminals.

T F 24. The brightness control of an oscilloscope is most often referred to as the focus control.

T F 25. The assembly known as the "electron gun" is contained in the CRT of a scope.

T F 26. Specific information in regards to test instruments is contained in the individual instruction or operating manuals.

T F 27. The letter symbol for voltage is V.

T F 28. Voltage and electromotive force mean the same thing.

T F 29. The symbol ∞, which appears on some ohmmeter scales, means infinity

T F 30. Zeroing a meter is necessary to achieve accurate measurements.

T F 31. Electron flow in a DC circuit is always from negative to positive.

T F 32. To measure a DC voltage drop, the meter is connected across a resistor and polarity must be observed.

T F 33. When taking a resistance measurement, the circuit being tested may be left on or turned off.

T F 34. Both current and voltage move or flow through a circuit.

T F 35. The function switch on a meter is used to set the needle or pointer to zero.

T F 36. When measuring an unknown value of voltage, the meter range switch should be set in its highest position.

STUDENT LABORATORY COMPETENCY RECORD

COMPETENCY NO. 5 - TO DEMONSTRATE A WORKING KNOWLEDGE OF TEST EQUIPMENT.

Student's Name _____

Social Security No. _____

_____ _____ _____

Verfication Signature (Instructor) Date School

		Satis-factory	Unsatis-factory
TASK: I	Demonstrate proficiency in using the multimeter to measure voltage, current resistance.		
A.	Show the correct technique for measuring AC voltages.		
B.	Show the correct technique for measuring DC voltages.		
C.	Show the correct technique for measuring AC current.		
D.	Show the correct technique for measuring DC current.		
E.	Show the correct technique for measuring resistance.		
TASK: II	Demonstrate proficiency in using the multimeter check resistors, potentiometers, capacitors, diodes, transformers, transistors, and continuity check.		
A.	Demonstrate proper laboratory techniques to determine value and condition of resistor with multimeter.		
B.	Demonstrate proper laboratory techniques to determine value and condition of potentiometers with multimeters.		
C.	Demonstrate proper laboratory techniques to determine condition of capacitors with multimeters.		
D.	Demonstrate proper laboratory techniques to determine condition and cathode lead of diodes with multimeter.		
E.	Demonstrate proper laboratory techniques to determine condition of transformers with multimeter.		
F.	Demonstrate proper laboratory techniques to determine condition and type of transistor (PNP or NPN) with multimeter.		
G.	Demonstrate proper laboratory techniques to use a multimeter to check out for continuity.		

		Satis-factory	Unsatis-factory
TASK: III	Demonstrate proficiency in using the oscilloscope to measure peak-to-peak voltage, DC voltage, and period of sine wave.		
	A. Show proficiency in measuring peak-to-peak voltage with oscilloscope.		
	B. Show proficiency in measuring DC voltage with oscilloscope.		
	C. Show proficiency in determining period of sine wave with oscilloscope.		

VIII. JOB OPPORTUNITIES

JOB OPPORTUNITIES

Many of the competencies listed in this booklet lead to jobs that are available in the 10 counties served by the 26 Local Education Agencies and Indian Hills Community College in Southeastern Iowa. Students, teachers, and counselors may use the following information in designing course emphases for more effective instruction and counseling.

JOB OPPORTUNITIES

Many electronic positions available are listed along with the Dictionary of Occupational Titles.

Other titles and occupations in the Department of Occupational Titles series may apply as determined by the instructor.

DICTIONARY OF OCCUPATIONAL TITLES CODE NUMBER	OCCUPATIONAL TITLES
726.687-010	Electronics Worker
726.684-018	Electronic Assembler
722.381-010	Assembler (telephone & telegraph)
728.684-010	Cable Maker
728.687-010	Wireworker
723.131-010	Supervisor, Small Appliance Assembly
723.381-010	Electrical Appliance Repairer
723.584-010	Appliance Repairer
723.684-014	Assembler I Lamp Wirer
723.687-014	Tester and Inspector, Lamps (light, fix.)
724.281-010	Transformer Tester